US007130274B2

(12) **United States Patent**
Chang et al.

(10) **Patent No.: US 7,130,274 B2**
(45) **Date of Patent: Oct. 31, 2006**

(54) **METHOD FOR DETECTING CONNECTION POLARITY OF NETWORK TRANSMISSION LINES AND ASSOCIATED DETECTION CIRCUIT**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1094 days.

(21) Appl. No.: **10/064,259**

(22) Filed: **Jun. 26, 2002**

(65) **Prior Publication Data**

US 2003/0057932 A1 Mar. 27, 2003

(30) **Foreign Application Priority Data**

Sep. 21, 2001 (TW) ..... 90123374 A

(51) **Int. Cl.**
G01R 31/08 (2006.01)

(52) **U.S. Cl.** **370/242**; 370/248; 714/712

(58) **Field of Classification Search** 370/242, 370/248, 250, 251; 714/712, 715; 375/360, 375/364; 327/18–27, 28–38
See application file for complete search history.

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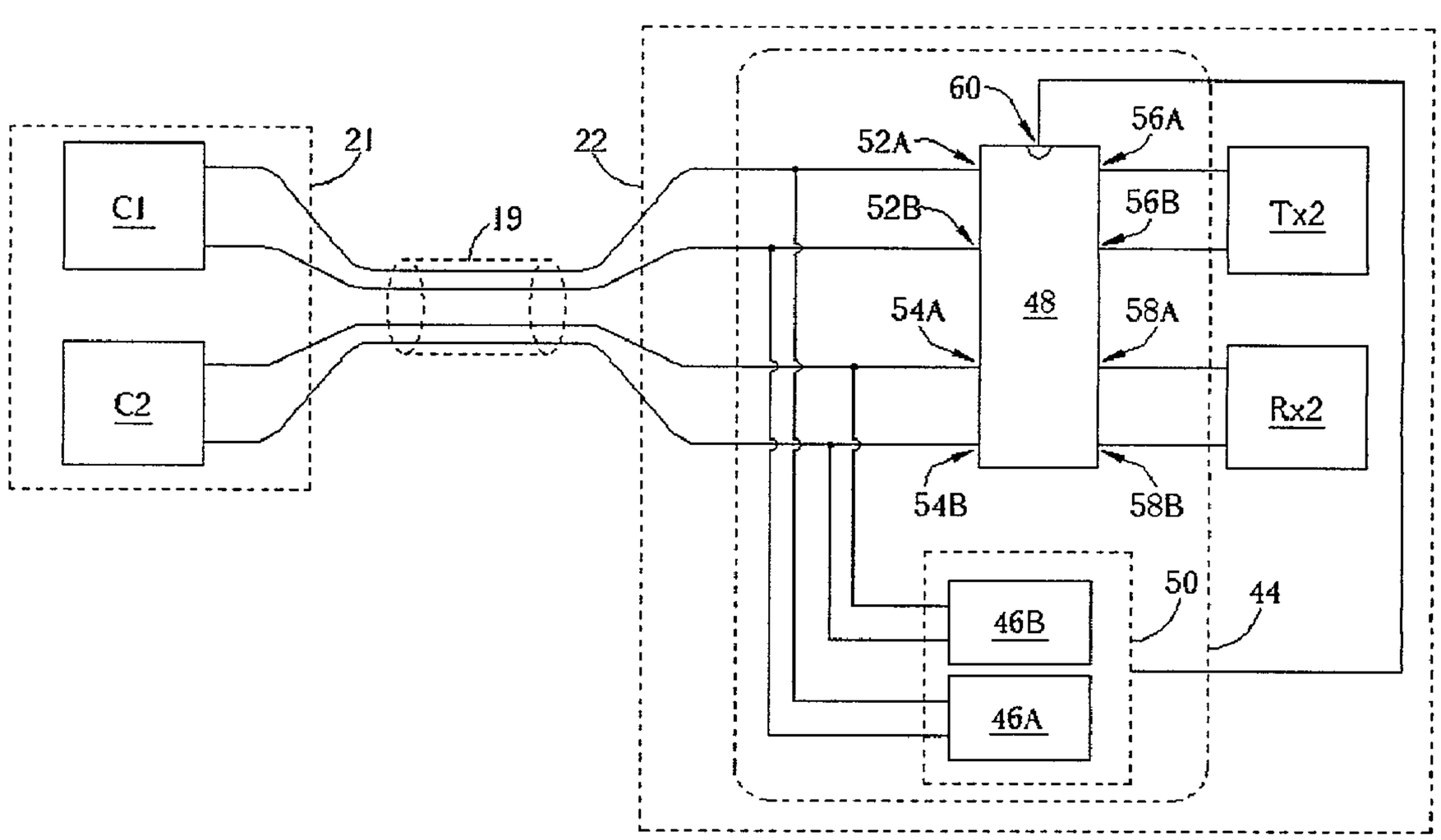
(57) **ABSTRACT**

A method and associated detecting circuitss for detecting and correcting a connection polarity of a network transmission line include two network clients and a network transmission line. One network client utilizes a detecting circuit to count and compare the number of signal pulses at the receiving and transmitting ports to determine if the connection polarity is correct or inverted. The detecting circuit can switch the connection polarity if required to correct it.

11 Claims, 5 Drawing Sheets



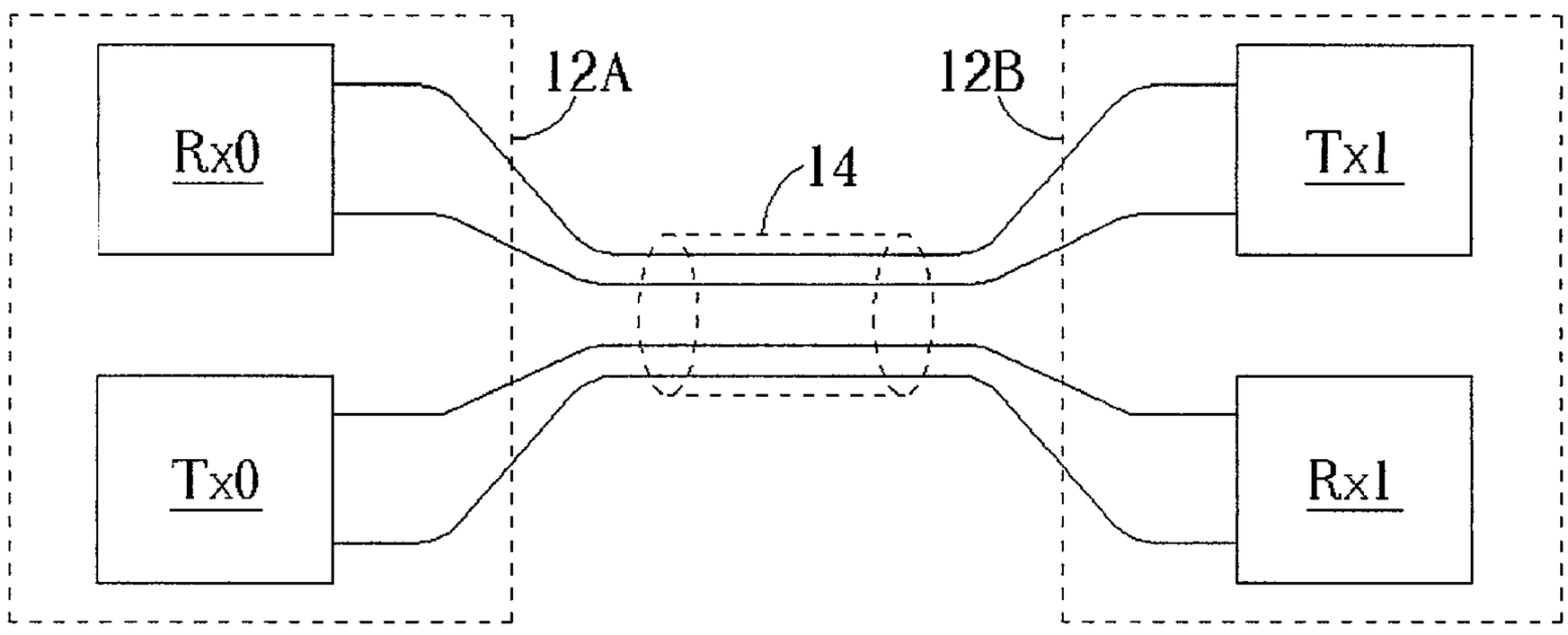


Fig. 1A Prior art

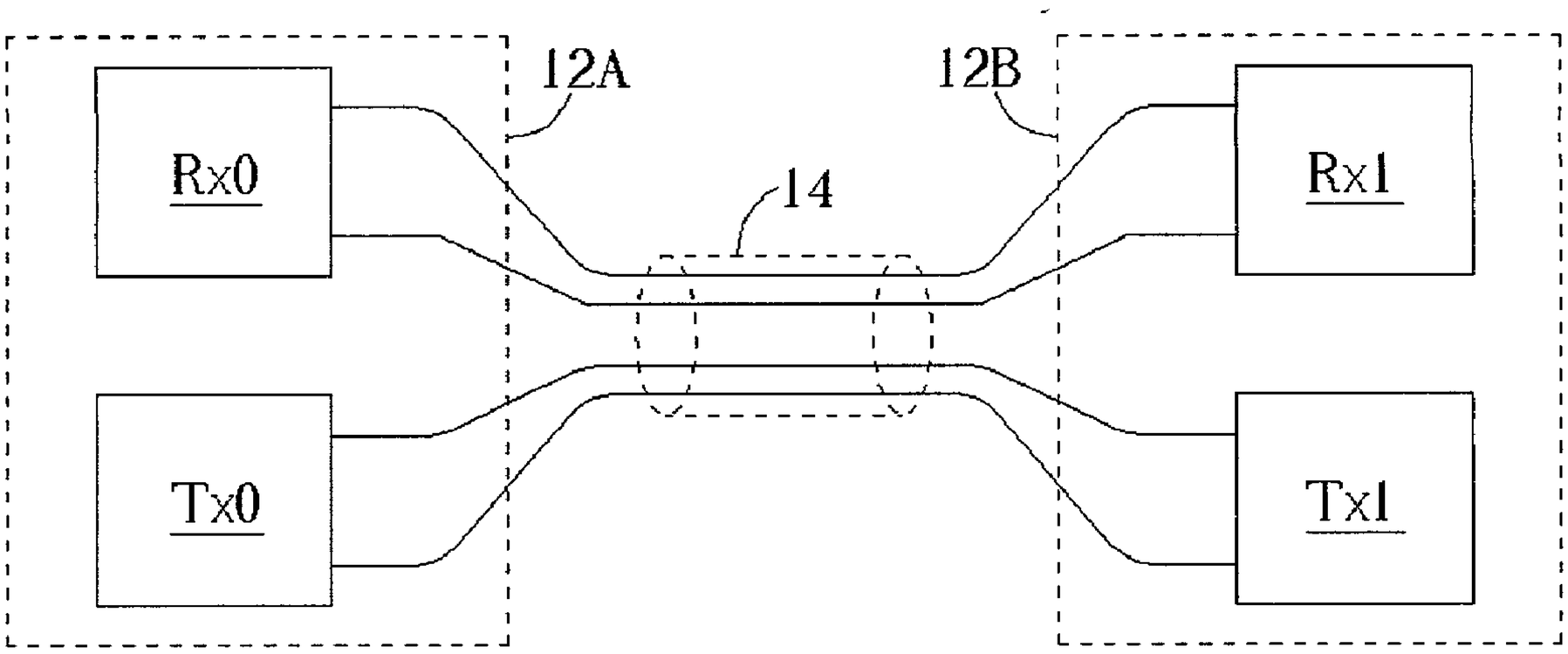


Fig. 1B Prior art

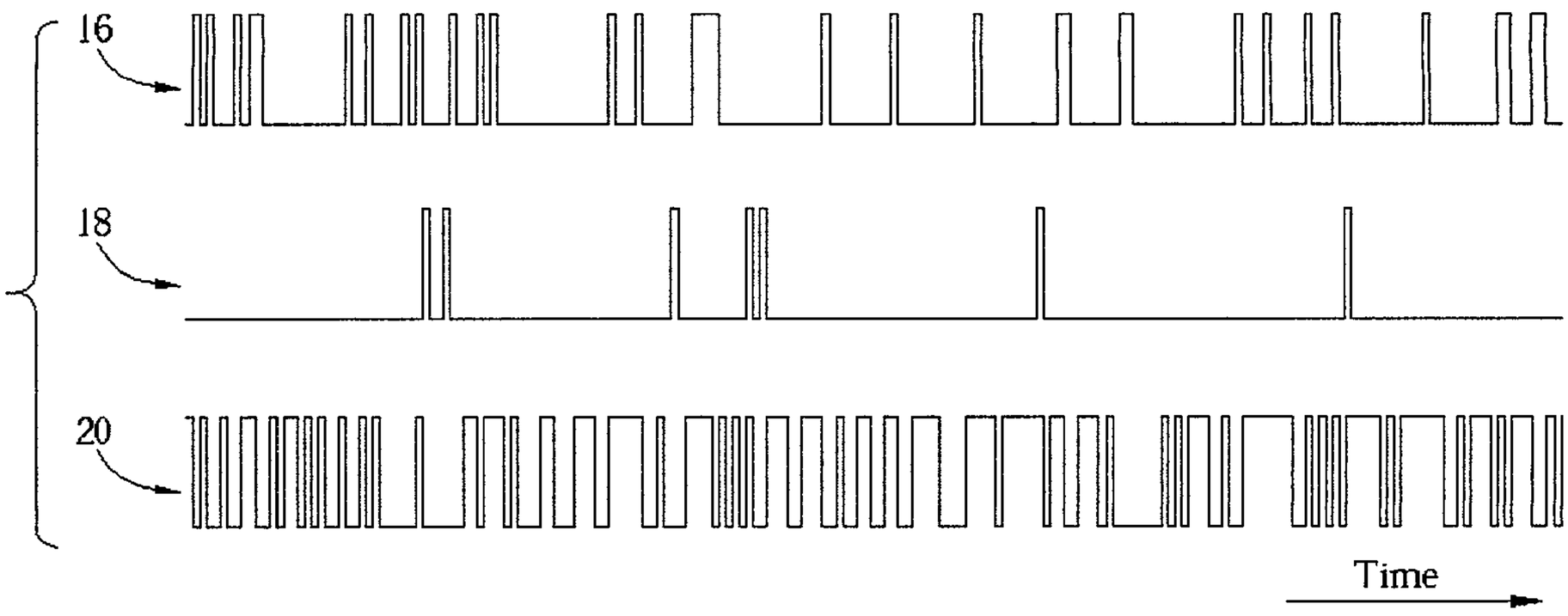


Fig. 2

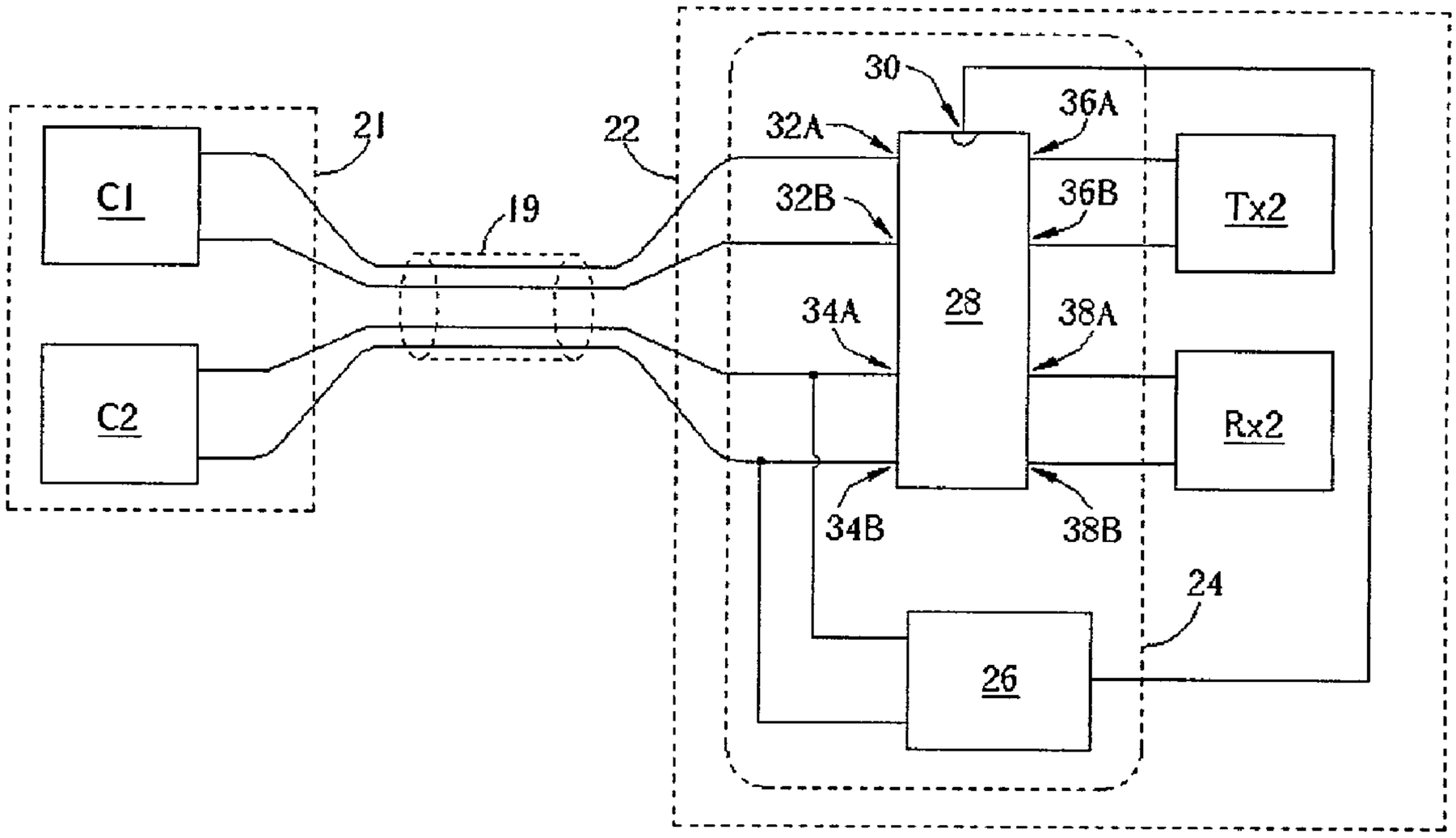


Fig. 3

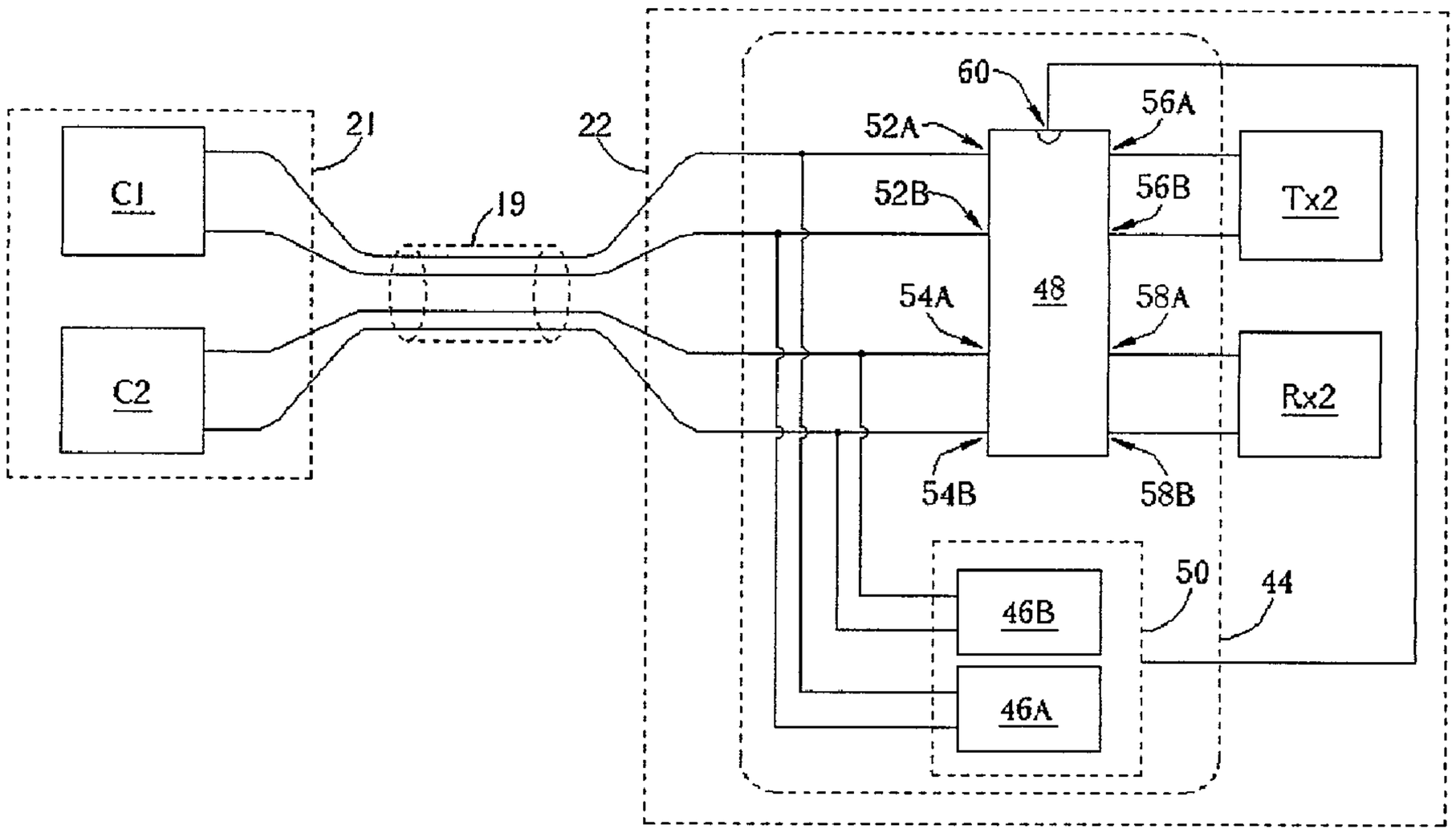

C1
C2
21
19
22
60
52A
52B
54A
54B
48
56A
56B
58A
58B
Tx2
Rx2
46B
46A
50
44

Fig. 4

METHOD FOR DETECTING CONNECTION POLARITY OF NETWORK TRANSMISSION LINES AND ASSOCIATED DETECTION CIRCUIT

BACKGROUND OF INVENTION

1. Field of the Invention

The present invention relates to a method and associated detecting circuits for detecting connection polarity of network transmission lines, and more particularly, to a method and associated detection circuits for detecting and correcting the connection polarity of network transmission lines by counting the number of signal pulses.

2. Description of the Prior Art

In a modern, information based society, computer networks allow people to exchange information. Hence, the manufacture and maintenance of these computer networks is an important issue.

Please refer to FIG. **1**A. FIG. **1**A is a schematic diagram of a connection between two network clients **12**A and **12**B via a network transmission line **14**. The clients **12**A and **12**B can be a switch, a router, a terminal of a network system, or other types of network clients. The transmission media between these two clients can be an Ethernet, in which the network transmission line **14** is typical Ethernet transmission cable. The connection port of each client has two ports, a transmitting port and a receiving port, for exchanging information via the network transmission line **14**. A transmitting port Tx**0** and a receiving port Rx**0** are provided in the client **12**A, whereas a transmitting port Tx**1** and a receiving port Rx**1** are provided in the client **12**B. Each port transmits or receives, for example, a differential signal by a pair of wires inside the network transmission line **14**. Under a correct connection, the transmitting port Tx**0** of the client **12**A connects to the receiving port Rx**1** of the client **12**B and the receiving port Rx**0** of the client **12**A connects to the transmitting port Tx**1** of the client **12**B via the network transmission line **14**, as shown in FIG. **1**A, so as to provide a correct connection polarity. If the connection polarity is correct then the two clients **12**A and **12**B can communicate properly.

In practical situations, it happens that the connection polarity of the network transmission line **14** connected between the clients **12**A and **12**B is inverted. Please refer to FIG. **1**B. FIG. **1**B is a schematic diagram of the network system shown in FIG. **1**A but with inverted connection polarity. That is, the transmitting port Tx**1** of the client **12**B connects to the transmitting port Tx**0** of the client **12**A instead of the receiving port Rx**0**. Similarly, the receiving port Rx**1** of the client **12**B does not correctly connect to the corresponding transmitting port Tx**0** of the client **12**A instead of the receiving port Rx**0**. Thus, the receiving ports Rx**0** and Rx**1** of the clients **12**A and **12**B will not receive any meaningful signals, since the network system malfunctions.

SUMMARY OF INVENTION

It is therefore a primary object of the invention to provide a method and associated detecting circuits for detecting and correcting the connection polarity of network transmission lines so as to guarantee that a network system functions normally.

According to the invention, a method for detecting a connection polarity of a network transmission line comprises a connection port counting a first number of signals transmitted via a first transmission line during a predetermined interval and counting a second number of signals transmitted via a second transmission line during a predetermined interval. The connection port determines that the connection polarity of the network transmission line is correct when a difference between the first number and the second number is less than a threshold value. Conversely, the connection port determines that the connection polarity of the network transmission line is inverted when a difference between the first number and the second number is greater than a threshold value.

It is an advantage of the claimed invention that the above method and the associated detecting circuitss can detect and correct the connection polarity of a network transmission line to guarantee that information can be shared on the network.

These and other objects of the claimed invention will no doubt become obvious to those of ordinary skill in the art after reading the following detailed description of the preferred embodiment that is illustrated in the various figures and drawings.

BRIEF DESCRIPTION OF DRAWINGS

FIG. **1**A is a schematic diagram of a connection between two clients via a network transmission line.

FIG. **1**B is a schematic diagram of the network system shown in FIG. **1**A wherein the connection polarity is inverted.

FIG. **2** shows waveforms of signal pulses triggered by transmission signals on a network transmission line when the network transmission line is connected in different ways.

FIG. **3** is a circuit schematic diagram for detecting and correcting the polarity of a network transmission line according to a preferred embodiment of the present invention.

FIG. **4** is a schematic diagram of another embodiment according to the present invention.

DETAILED DESCRIPTION

Several kinds of encoded digital signals, with different voltage levels, can be used to transmit signals across a network. Consider an Ethernet 100 Base-T MLT-3 signal as an example. A high voltage level signal A represents a digital "1", a middle voltage level signal A represents a digital "0", and a low voltage level signal A represents a digital "−1". A reference voltage level is set at first. A signal pulse is triggered at a client if the voltage level of a signal on a network transmission line is higher than the reference voltage level. For example, if the reference voltage level is set as the high voltage level reference, each high voltage level signal will correspondingly trigger a signal pulse. A number of signal pulses triggered by a digital signal associates to a flow rate of the digital signal.

The present invention determines and corrects the connection polarity of a network transmission line by utilizing the quantity and the frequency of signal pulses. Shown in FIG. **2** are three waveforms of signal pulses triggered by transmission signals on a network transmission line. The horizontal-axis of each waveform represents time and the vertical-axis is the amplitude of signal. If clients **12**A and **12**B of a network system are correctly connected, as shown in FIG. **1**A, the waveform of signal pulses triggered by transmission signals on each line of the network transmission line will appear approximately like the waveform **16**. Typically, the transmitting port of each client transmits nearly the same flow rate of digital signals to the corresponding receiving port of the other client.

On the contrary, when the connection polarity of the network transmission line is inverted as shown in FIG. **1**B, a measurable difference appears in the number of signal pulses triggered. Because the connection polarity of the network transmission line is inverted, the waveform of

signal pulses appearing on the line connected between the two receiving ports looks like the waveform **18** shown in FIG. **2**. The frequency of the triggered signal pulses on the line is very low because both ends of the line are receiving ports that will not transmit any signal. The only signals actually seen on the line are generated by noise or interference, such as lightening. On the other hand, the line connecting the two transmitting ports is filled with signals as both transmitting ports are attempting to transmit, illustrated as the waveform **20** in FIG. **2**. In other words, when the connection polarity of a network system is inverted, the number of signal pulses on the line connected between two transmitting ports is very large, and the number of signal pulses on the line connected between two receiving ports is very small. When the connection polarity of a network system is correct, the number of signal pulses on each line lies between these previous two numbers.

Please refer to FIG. **3**. FIG. **3** is a circuit schematic diagram of a preferred embodiment according to the present invention for detecting and correcting the connection polarity of a network system. Two clients **21** and **22** connected by the transmission line **19** form a typical network system. A detecting circuit is installed in the client **22**. The clients can be a switch, a router, a terminal, or other types of network clients. The network system formed by the network transmission line **19** can be an Ethernet system. The client **21** comprises two ports C**1** and C**2** each connected to a line (a pair of wires as shown in FIG. **3**) of the network transmission line **19** for transmission of mutually counter-phased differential-form transmission signals. The client **22** also comprises two ports; one being a transmitting port Tx**2** and the other being a receiving port Rx**2**. A detecting circuit **24**, installed in the client **22**, comprises a counter **26** and a multiplexer **28**. The counter **26**, connects to one line (two wires) of the network transmission line **19**, receives differential-form transmission signals on the line and counts a number of signal pulses. The counter **26** also sends a control signal to the multiplexer **28** via a control end **30** of the multiplexer **28**. The multiplexer **28** comprises two differential input ports, **32**A and **32**B (a first differential input pair) and **34**A and **34**B (a second differential input pair). The multiplexer also comprises two differential output ports, **36**A and **36**B (a first differential output pair) and **38**A and **38**B (a second differential output pair). The multiplexer **28** can switch the differential input pairs to connect with different differential output pairs based on the control signal generated by the counter **26**.

FIG. **3** also shows that the input ports **32**A and **32**B of the multiplexer **28** connect to the port C1 of the client **21** whereas the output ports **36**A and **36**B connect to the transmitting port Tx**2**. The other input ports **34**A and **34**B connect to the port C**2** of the client **21** via the network transmission line **19** whereas the output ports **38**A and **38**B connect to the receiving port Rx**2**. The present invention can detect and correct the connection polarity of a network system using the detecting circuit **24** installed on one client **22** regardless of if the port C**1** or C**2** of the other client **21** is a transmitting port or a receiving port.

The operation of the detecting circuit **24** of the preferred embodiment of the present invention is described as follows. The multiplexer **28** connects the first and second input pairs respectively to the first and second output pairs such that, the port C**1** connects to the transmitting port Tx**2** and the port C**2** connects to the receiving port Rx**2**. The counter **26** then counts the number of signal pulses on the line connected between the port C**2** and the receiving port Rx**2**. Practically, the counter **26** comprises a comparator for comparing a voltage level of transmission signals with a predetermined voltage level and a Schmitt trigger for generating signal pulses. For example, if the voltage level of transmission signal exceeds the predetermined voltage level, the Schmitt trigger will trigger a signal pulse. The Schmitt trigger can suppress the glitch interference.

The counter **26** determines the connection polarity of the network transmission line according to the quantity and the frequency of signal pulses. As discussed previously, a very small number of signal pulses, less than a threshold value, received by the counter **26**, shown as waveform **18** in FIG. **2**, indicates that the port C**2** of the client **21** does not transmit any meaningful signal and is in fact a receiving port. In other words, the two receiving ports C**2** and Rx**2** are connected. Therefore the counter **26** generates a control signal to the control end **30** of the multiplexer **28** causing the multiplexer **28** to switch the connection polarity for input pairs and output pairs. As a result, the port C**2** of the client **21** connects correctly to the transmitting port Tx**2** of the client **22** and the port Cl of the client **21** also correctly connects to the receiving port Rx**2** of the client **22**.

If the connection polarity is correct then the number of signal pulses received by the counter **26** will exceed the threshold value. The counter **26** thus determines that the connection polarity of the network transmission line **19** is correct. Of course, the counter **26** will not assert a control signal to the multiplexer **28** to switch the connection polarity of the first and the second input and output pairs. Generally, if the number of signal pulses received by the counter **26** is smaller than a predetermined threshold value, set according to a flow rate of digital signals of normal transmission signals, the connection polarity of the network transmission line **19** is determined to be inverted.

Please refer to FIG. **4**. FIG. **4** is a schematic diagram of another embodiment **44** according to the present invention. Similar to the network system shown in FIG. **3**, the client **21** connects to the client **22** via the network transmission line **19**. The client **21** comprises two ports C**1** and C**2** whereas the other client **22** comprises a detecting circuit **44**, transmitting port Tx**2**, and a receiving port Rx**2**. The detecting circuit **44** comprises a counter **50** and a multiplexer **48**. The multiplexer **48**, similar to the first embodiment, is connected between the network transmission line **19**, and the transmitting port Tx**2** and receiving port Rx**2**. The multiplexer **48** has a first differential input pair (input port **52**A and **52**B), a second differential input pair (input port **54**A and **54**B), a first differential output pair (output port **56**A and **56**B), and a second differential output pair (output port **58**A and **58**B). The two pairs of input and output ports can be switched in response to a control signal, transmitted from the counter **50**, of a control end **60**. The counter **50** comprises two counting units **46**A and **46**B. The counting unit **46**A counts the number of signal pulses on the first differential input pair whereas the counting unit **46**B counts the number of signal pulses on the second differential input pair. The counter **50** determines the connection polarity of the network transmission line **19** in response to a counting result of the counting units **46**A and thus controls the multiplexer **48** via the control end **60** to properly connect the network transmission line **19** with the transmitting port Tx**2** and receiving port Rx**2**.

The present invention can detect and further correct the connection polarity of network transmission line **19** by the detecting circuit **44** installed in the client **22** regardless of if the port C**1** or C**2** of the other client **21** is a transmitting port or a receiving port. Suppose that initially the ports C**1** and C**2** of client **21** are connected through the multiplexer **48** to transmitting port Tx**2** and receiving port Rx**2** respectively. The counting units **46**A and **46**B count the number of signal pulses on the lines between the port Cl and the transmitting port Tx**2**, and the port C**2** and the receiving port Rx**2** respectively. The counter **50** compares the transition numbers of signals of the counting units **46**A and **46**B, and any

significant difference between these numbers of signals, as illustrated by the waveforms **18** and **20** in FIG. **2**, means that the port C**1** is a transmitting port and the port C**2** is a receiving port, so the connection polarity is inverted. A relative too large transition numbers of signals at a counting unit than the other transition number represents that the two ports connected at both ends of the line are transmitting ports, while the other two ports connected at both ends of the line are receiving ports. After determining an incorrect connection polarity, the counter **50** will control the multiplexer **48** to switch the connection polarity between the input pairs and the output pairs. That is, the input ports **52**A and **52**B will be connected to the output ports **58**A and **58**B, and the input ports **54**A and **54**B will be connected to the outputs port **56**A and **56**B. Thus, the determined transmitting port C**1** will be correctly connected to the receiving port Rx**2** and the determined receiving port C**2** will likewise be correctly connected to the transmitting port Tx**2**.

On the other hand, if the numbers of signals at counting units **46**A and **46**B are almost equal, then the connection polarity of the network transmission lines **19** will be taken as correct. That is, port C**1** is the receiving port and the port C**2** is the transmitting port of the client **21**. According to this comparison result for the two counting units, the counter **50** determines that the connection polarity of the network transmission line **19** is correct and, of course, needs not to switch the connection state of the multiplexer **48**.

Practically, if the difference between the totals counted by the two counting units **46**A and **46**B exceeds a predetermined value, set according to the characteristic of the network signals, the connection polarity is inverted. If the difference between these two totals is not large enough to exceed the predetermined value, the connection polarity is correct. Each counting unit (**46**A and **46**B) can comprise a comparator for comparing voltage levels of transmission signals with a predetermined voltage level, and a Schmitt trigger for generating signal pulses. According to the comparison, the Schmitt trigger can further prevent glitches.

In contrast to the prior art, the present invention provides a method and related apparatus for detecting the connection polarity of a network transmission line so that an inverted connection polarity of the transmission line can be corrected.

Those skilled in the art will readily observe that numerous modifications and alterations of the device may be made while retaining the teachings of the invention. Accordingly, the above disclosure should be construed as limited only by the metes and bounds of the appended claims.

What is claimed is:

1. A method for detecting a connection polarity of a network transmission line, one terminal of the network transmission line connected to a connection port, the network transmission line comprising a first transmission line and a second transmission line; the method comprising:

the connection port counting a first number of signals transmitted via the first transmission line during a predetermined interval;

the connection port counting a second number of signals transmitted via the second transmission line during said predetermined interval;

the connection port determining that the connection polarity of the network transmission line is correct when a difference between the first number and the second number is less than a first threshold value; and

the connection port determining that the connection polarity of the network transmission line is inverted when a difference between the first number and the second number is greater than a second threshold value.

2. The method of claim **1** further comprising switching the first transmission line and the second transmission line connected to the connection port when the connection polarity of the network transmission line is inverted.

3. The method of claim **1** wherein the network transmission line is used for transmitting a 100Base-T signal.

4. The method of claim **3** wherein the 100Base-T signal is an MLT-3 coded signal.

5. The method of claim **1** further comprising comparing voltage levels of signals transmitted via the network transmission line with a predetermined level for generating the first number and the second number.

6. The method of claim **1** further comprising transforming each signal transmitted via the network transmission line into a pulse signal for counting the first number and the second number.

7. The method of claim **6** wherein said transforming step comprises using a Schmitt trigger for transforming each signal transmitted via the network transmission line into the pulse signal.

8. A detection circuit for detecting a connection polarity of a network transmission line of a receiver terminal having a receiving terminal and a transmitting terminal, the detection circuit comprising:

a first counter for counting a first number of signals received by the receiving terminal of the receiver terminal;

a second counter for counting a second number of signals received by the transmitting terminal of the receiver terminal;

a multiplexer for coupling the network transmission line with the receiving terminal and the transmitting terminal; and

a controller for determining whether the connection polarity of the network transmission line is correct and signaling the multiplexer correspondingly to control the connection polarity for the network transmission line, wherein the controller signals the multiplexer for maintaining the connection polarity of the network transmission line when a difference between the first number and the second number is less than a threshold value.

9. The detection circuit of claim **8** wherein the controller signals the multiplexer for switching the connection polarity of the network transmission line when a difference between the first number and the second number is greater than a threshold value.

10. The detection circuit of claim **8** wherein each signal transmitted via the network transmission line is an MLT-3 coded signal.

11. The detection circuit of claim **8** further comprising a Schmitt trigger for transforming each signal transmitted via the network transmission line into a pulse signal for counting the number for said each signal.

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